BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D. C. 20036

SUBJECT: Structural Considerations in CM-SM/LM-ATM Backup Mission - Case 620

DATE: August 13, 1968

FROM: W. W. Hough

ABSTRACT

Structural loading conditions unique to the backup CM-SM/LM-ATM missions have been analyzed and compared with present baseline mission requirements. Because the LM-A is being designed for SM SPS burns, and because all other unique loading conditions are non-critical (i.e., higher loading conditions exist in the baseline mission profile), it is concluded that no new structural problems occur because of backup mission requirements.

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MEMORANDUM FOR FILE

Launch and maneuvering profiles of the CM-SM/LM-ATM backup mission impose structural loading conditions on the spacecraft that are unique to this mission. Axial loads induced in the LM-ATM by an SM SPS burn and additional lateral loads induced in the payloads by yaw-steering of the launch vehicle in the 63 1/2° inclination mission are the significant unique loads.

SPS Burn

Capability to withstand an SPS burn is a design requirement on the LM-A. The Crew Provisions Stowage Module (CPSM) and its attachment to the basic LM structure is being designed to the following limit loads:

1. Axial loads consistent with Apollo LM capability, or P = -32,000 pounds/+25,000 pounds.

2. Bending and torsional loads consistent with MDA capability, or M = ±300,000 inch pounds and T = ±150,000 inch pounds.

The expected dynamic compressive load at the CM/LM-A interface induced by the SPS start transient with maximum thrust buildup is between P = -22,000 pounds and P = -26,000 pounds, well within the Apollo LM design limit load of -32,000 pounds. The maximum expected tensile load is less than P = +10,000 pounds. Because the CPSM is tied to the LM-A at only four points, some minor modifications to the basic LM structure in the local attachment areas will be required to bring LM-A capability in line with that of Apollo LM.

Dynamically amplified loads in the ATM due to an SPS start transient are opposite in direction to the dominant launch loads. However, the maximum axial load factor at the ATM will not exceed -1g due to SPS start, and the boost environment load factors are +4.68 g's and -2.11 g's, the latter occurring at engine shutdown. Therefore, launch environment is the critical case, and the ATM will be designed for it whether the mission is baseline or backup.

Yaw Steering

To insert the payload in a 63 1/2° inclined orbit, a launch vehicle yaw steering maneuver is required, and this maneuver can occur simultaneously with pitch-down. The total static lateral load induced by angular acceleration can be the square-root-of-two times the lateral load induced by just pitch-rate initiation. However, this load is far from critical. For example, the maximum lateral load factor at the ATM for simultaneous pitch and yaw initiation caused by the J-2 engine gimbaling at its maximum rate is 0.03 g's. The critical lateral load factor is 0.725 g's at liftoff.

Conclusion

Because the LM-A is being designed for SPS burns, and because all other loading conditions unique to the backup mission are non-critical, it is concluded that no new structural problems occur because of backup mission requirements.

W. W. Hough

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